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(54) **VEHICLE RADIO INTERFERENCE SENSOR DEVICE**

FAHRZEUGFUNKINTERFERENZSENSORVORRICHTUNG

DISPOSITIF DE CAPTEUR D'INTERFÉRENCES RADIO DE VÉHICULE

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(73) Proprietor: **NXP B.V.**
5656 AG Eindhoven (NL)

(72) Inventors:
- **KERSELAERS, Anthony**
  Redhill, Surrey RH1 1QZ (GB)
- **GOMME, Liesbeth**
  Redhill, Surrey RH1 1QZ (GB)

(74) Representative: **Hardingham, Christopher Mark**
NXP Semiconductors
Intellectual Property Group
Abbey House
25 Clarendon Road
Redhill, Surrey RH1 1QZ (GB)

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Description

BACKGROUND

[0001] Interference occurs when unwanted radio frequency signals disrupt the use of automobile's radio system. Interference may prevent reception altogether, may cause only a temporary loss of a signal, or may affect the quality of the sound. The interference in automobile radios comes from a variety of sources. The most common sources for interference are electric and electronic systems in an automobile. One probable cause of this type of interference is the cars spark plug wires which degrade over time. Another source of interference can be the charging system of your car. The alternator which produces electricity to charge your cars battery is essentially a source of electro-magnetic energy.

[0002] Japanese Patent Application, publication number JP2011-176659 discloses a system of cancelling noise generated in a wireless device, comprising second noise extraction units and an adder.

SUMMARY

[0003] The invention is defined by the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] So that the way the features of the present invention can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only typical embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments. Advantages of the subject matter claimed will become apparent to those skilled in the art upon reading this description in conjunction with the accompanying drawings, in which like reference numerals have been used to designate like elements, and in which:

FIG. 1 depicts noise paths caused by automobile engine and electronic components;
FIG. 2 shows a noise sensor in accordance with one or more embodiments;
FIG. 3 shows a noise sensor in accordance with one or more embodiments;
FIG. 4 shows a noise sensing coil in accordance with one or more embodiments;
FIG. 5 shows a plurality of noise sensors installed in an automobile in accordance with one or more embodiments; and
FIG. 6 shows a noise cancellation circuit in accordance with one or more embodiments.

[0005] Note that figures are not drawn to scale. Intermediate steps between figure transitions have been omitted so as not to obfuscate the disclosure. Those intermediate steps are known to a person skilled in the art.

DETAILED DESCRIPTION

[0006] Many well-known manufacturing steps, components, and connectors have been omitted or not described in detail in the description so as not to obfuscate the present disclosure.

[0007] Figure 1 depicts noise paths caused by automobile engine and electronic components. The length of the rod antenna 100 is typically in the range of 10 centimeters to 80 centimeters cm. The rod antenna 100 is mounted on the rooftop of a vehicle. The received radio signals are amplified by a low noise amplifier positioned at the antenna feeding port. The feeding port has two feeding connections, the first connection is at the start of the rod antenna 100 close to the rooftop and the second connection is at the rooftop.

[0008] The engine 104 may be powered by batteries. When DC voltage is converted into variable AC voltage to drive the vehicles drive train, such conversion also generates electromagnetic fields. These electromagnetic fields induce current and voltage in the vehicle's chassis and rooftop. Since the rooftop is part of the antenna 100, the induced interference is coupled to the antenna feeding port. As depicted, the noise current path 102 passes through the rooftop and chassis and may interfere with the radio reception received through the antenna 100.

[0009] Figure 2 shows an interference sensor 200. The interference sensor 200 includes a first conductive plate 202 and a second conductive plate 204 separated from each other by the distance D. Between the first conductive plate 202 and the second conductive plate 204, there may be a non-conductive material or air. The interference sensor 200 also includes a sensor coil 206 that is energized by the electromagnetic field captured by the first conductive plate 202 and the second conductive plate 204 as well as the radio interference captured directly. The interference sensor 200 includes two connecting ports 208 to couple the interference sensor 200 with a noise reduction circuit (now shown).

[0010] Figure 3 shows an interference sensor 220 in another embodiment. The interference sensor 220 includes the first conductive plate 202 and the second conductive plate 204 separated from each other by an arbitrary distance D. The first conductive plate 202 and the second conductive plate 204 are coupled to a first amplifier 222. The interference sensor 220 further includes the sensor coil 206 coupled to a second amplifier 224. The output of the first amplifier 222 and the second amplifier 224 are combined using an adder 226 that adds amplified signals from the two conductive plates 202, 204 and from the sensor coil 206.

[0011] Figure 4 shows a schematic of the sensor coil

206. In some embodiments, the sensor coil 206 includes only one directional coil, e.g., a coil in X direction only. In another example, the sensor coil 206 may include coils in X and Y directions. Coils in three directions provide a better sensing as it can pick up the electromagnetic emission in all three directions and combine the sensed voltage. The coil may be a planar coil or a coil on a ferrite rod.

[0012] Figure 5 shows an example of placement of the interference sensors 200 or 220 in a vehicle 300. The interference sensor 200 or 220 is placed where the reception of the broadcast signal is minimal, e.g., inside the vehicle 300 and where the interference is correlated with the interference received by the antenna 100. The chassis of the vehicle 300 creates a faraday cage, hence the broadcast signal inside the vehicle 300 is the minimal. As depicted, one or more interference sensors 200 or 220 may be placed inside the vehicle 300 above driver's seat. Alternatively, the interference sensor 200 or 220 may be placed inside the vehicle 300 towards the rear under the antenna 100. Under the chassis of the vehicle 300 may also be an advantageous position because the radio signals are attenuated due to the ground which is capacitive coupled to the lower side of the chassis.

[0013] Figure 6 shows a noise cancellation circuit 400. The noise cancellation circuit 400 includes an interference sensor 200. In some embodiments, the interference sensor 220 may also be used. As discussed in Figure 5, the interference sensor 200 may be installed in a vehicle where there is a minimal amount of broadcast signal. The interference sensor 200 is installed coupled to the chassis of the vehicle. The interference captured by the interference sensor 200 is amplified by a low noise amplifier 408 and the amplified signal is inputted to a phase and amplitude changer 406 which is controlled by a signal processor 402. The phase and amplitude changer 406 is configured to produce a signal that is correlated to the signal from the antenna and similar in amplitude to the signal from the antenna after amplification by the low noise amplifier 406. The signal from the antenna includes the broadcast signal as well as the interference signal. The signal processor 402 the subtract the signal from the interference sensor path from the signal from the antenna path to produce a relatively noise and interference free broadcast signal.

[0014] Going back to Figure 5, the interference sensor 304 is installed close to the chassis of the vehicle 300 and is capacitively coupled to the chassis. Due to the electric field vector orientation, the interference field induces a voltage between the plate 202 and the plate 204. The field to voltage transfer function may be defined as follows:

$$V_1(x) = E(x)\, D\, Q\, \frac{C_s}{\varepsilon r\, (C_s + C_{amp.})}$$

[0015] Where:

V_1 = induced voltage
E = electric interference field
D = distance between the plates
Cs = capacity formed by the two plates
Camp = capacity of the amplifier connected to the sensor
εr = dielectric constant of the substrate between the two plates
Q = quality factor of the sensor including amplifier
x = position on the chassis

[0016] The conductive plates are measuring the common model signal which is represented by the electric field on the chassis of the vehicle 300. The differential mode signal, which are the circulating currents can be measured by means of their magnetic field. The magnetic field is captured by the sensor coil 206.

[0017] The conversion from magnetic interference fields to voltage in one coil can be defined as follows:

$$V_2(x) = Q\, 2\, \pi\, N\, Su\, \mu_0\, \mu_r\, H(x)\, F$$

[0018] Where:

N = the number of turns in the coil
F = frequency
Su = surface area of the coil core
H = the magnetic field at the receive coil
$\mu_o = 4 \cdot pi \cdot 10^{-7}$ H/m is magnetic permeability of vacuum
μ_r = relative magnetic permeability of the receive coil rod
x = position at the chassis
Q = quality factor of sensor including amplifier

[0019] Some or all of these embodiments may be combined, some may be omitted altogether, and additional process steps can be added while still achieving the products described herein. Thus, the subject matter described herein can be embodied in many different variations, and all such variations are contemplated to be within the scope of what is claimed.

[0020] While one or more implementations have been described by way of example and in terms of the specific embodiments, it is to be understood that one or more implementations are not limited to the disclosed embodiments. To the contrary, it is intended to cover various modifications and similar arrangements as would be apparent to those skilled in the art. Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

[0021] The use of the terms "a" and "an" and "the" and similar referents in the context of describing the subject matter (particularly in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly con-

tradicted by context. Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. Furthermore, the foregoing description is for the purpose of illustration only, and not for the purpose of limitation, as the scope of protection sought is defined by the claims as set forth hereinafter together with any equivalents thereof entitled to. The use of any and all examples, or exemplary language (e.g., "such as") provided herein, is intended merely to better illustrate the subject matter and does not pose a limitation on the scope of the subject matter unless otherwise claimed. The use of the term "based on" and other like phrases indicating a condition for bringing about a result, both in the claims and in the written description, is not intended to foreclose any other conditions that bring about that result. No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the invention as claimed.

[0022] Preferred embodiments are described herein, including the best mode known to the inventor for carrying out the claimed subject matter. Of course, variations of those preferred embodiments will become apparent to those of ordinary skill in the art upon reading the foregoing description. The inventor expects skilled artisans to employ such variations as appropriate, and the inventor intends for the claimed subject matter to be practiced otherwise than as specifically described herein. The invention is defined by the appended claims.

Claims

1. A vehicle (300) comprising a chassis, a driver seat, and an interference sensor device (220) comprising:

   a signal adder (226) having two input ports and two output ports;
   a first conductive plate (202);
   a second conductive plate aligned parallel to the first conductive plate (204);
   a non-conductive matter between the first conductive plate (202) and the second conductive plate (204), wherein the first conductive plate (202) is coupled to a first input of a first amplifier (222) and the second conductive plate (204) is coupled to a second input of the first amplifier (222), wherein an output of the first amplifier (222) is coupled to a first of the two input ports of the signal adder (226); and
   a sensor coil (206) having two ports each electrically coupled to a first input and a second input of a second amplifier (224),
   wherein an output of the second amplifier (224) is coupled to a second of the two input ports of the signal adder (226);
   wherein the interference sensor device is installed at either an inside bottom of chassis of the vehicle (300), or at an inside top of the chassis of the vehicle (300) above the driver seat.

2. The vehicle of claim 1, wherein the signal adder is configured to add signals received from the first and the second conductive plates and the sensor coil to produce a combined signal..

3. The vehicle of claim 1, wherein the signal adder is configured to be coupled to an amplifier through the two output ports.

Patentansprüche

1. Fahrzeug (300), umfassend ein Chassis, einen Fahrersitz und eine Interferenzsensoreinrichtung (220), umfassend:

   einen Signaladdierer (226) mit zwei Eingangsports und zwei Ausgangsports;
   eine erste leitfähige Platte (202);
   eine zweite leitfähige Platte, die parallel zu der ersten leitfähigen Platte (204) ausgerichtet ist;
   eine nichtleitende Materie zwischen der ersten leitfähigen Platte (202) und der zweiten leitfähigen Platte (204), wobei die erste leitfähige Platte (202) an einen ersten Eingang eines ersten Verstärkers (222) gekoppelt ist und die zweite leitfähige Platte (204) an einen zweiten Eingang des ersten Verstärkers (222) gekoppelt ist, wobei ein Ausgang des ersten Verstärkers (222) an einen ersten der zwei Eingangsports des Signaladdierers (226) gekoppelt ist; und
   eine Sensorspule (206) mit zwei Ports, die jeweils elektrisch an einen ersten Eingang und einen zweiten Eingang eines zweiten Verstärkers (224) gekoppelt sind,
   wobei ein Ausgang des zweiten Verstärkers (224) an einen zweiten der zwei Eingangsports des Signaladdierers (226) gekoppelt ist;
   wobei die Interferenzsensoreinrichtung entweder an einem innenseitigen Boden des Chassis des Fahrzeugs (300) oder an einer innenseitigen Oberseite des Chassis des Fahrzeugs (300) über dem Fahrersitz installiert ist.

2. Fahrzeug nach Anspruch 1, wobei der Signaladdierer ausgelegt ist zum Addieren von von der ersten und der zweiten leitfähigen Platte empfangenen Signalen und die Sensorspule ein kombiniertes Signal erzeugen soll.

3. Fahrzeug nach Anspruch 1, wobei der Signaladdierer ausgelegt ist zum Gekoppeltwerden an einen

Verstärker durch die beiden Ausgangsports.

Revendications

1. Véhicule (300) comprenant un châssis, un siège de conducteur, et un dispositif de détection d'interférence (220) comprenant :

   un additionneur de signaux (226) ayant deux ports d'entrée et deux ports de sortie ;
   une première plaque conductrice (202) ;
   une seconde plaque conductrice alignée parallèlement à la première plaque conductrice (204) ;
   une matière non conductrice entre la première plaque conductrice (202) et la seconde plaque conductrice (204), où la première plaque conductrice (202) est couplée à une première entrée d'un premier amplificateur (222) et la seconde plaque conductrice (204) est couplée à une seconde entrée du premier amplificateur (222), où une sortie du premier amplificateur (222) est couplée à un premier des deux ports d'entrée de l'additionneur de signaux (226) ; et
   une bobine de capteur (206) ayant deux ports, chacun étant couplé électriquement à une première entrée et une seconde entrée d'un second amplificateur (224),
   où une sortie du second amplificateur (224) est couplée à un second des deux ports d'entrée de l'additionneur de signaux (226) ;
   où le dispositif de détection d'interférence est installé soit à l'intérieur du bas du châssis du véhicule (300), soit à l'intérieur du haut du châssis du véhicule (300) au-dessus du siège du conducteur.

2. Véhicule selon la revendication 1, dans lequel l'additionneur de signaux est configuré pour additionner les signaux reçus des première et seconde plaques conductrices et de la bobine de capteur pour produire un signal combiné.

3. Véhicule selon la revendication 1, dans lequel l'additionneur de signaux est configuré pour être couplé à un amplificateur par l'intermédiaire des deux ports de sortie.

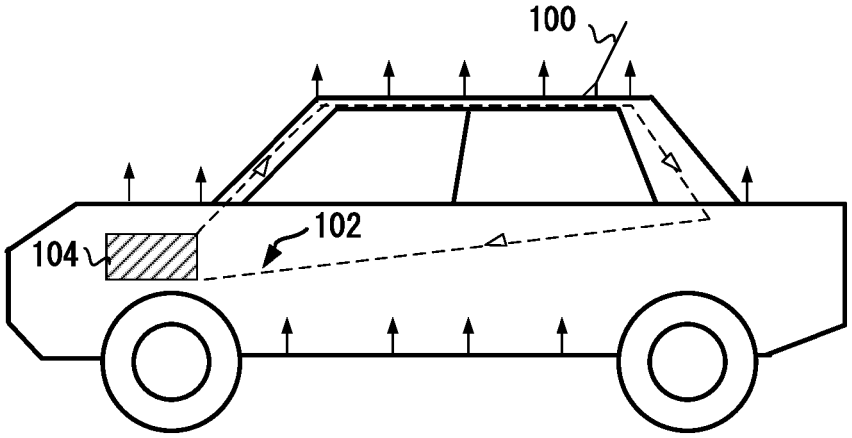

Fig. 1 (Prior Art)

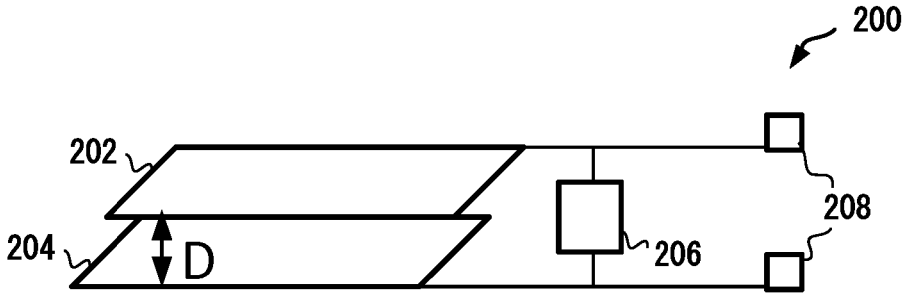

Fig. 2

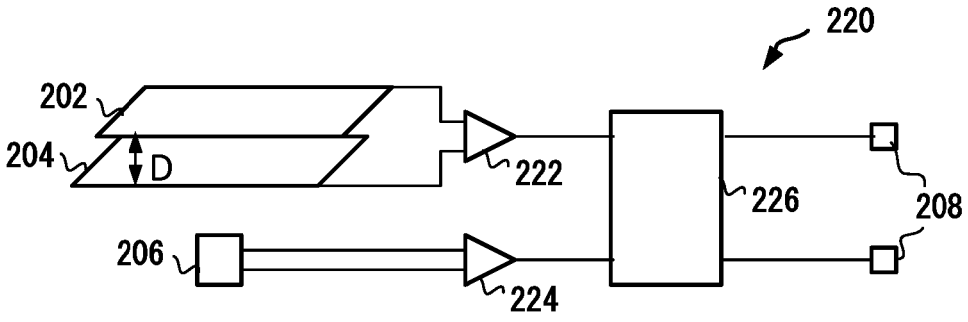

Fig. 3

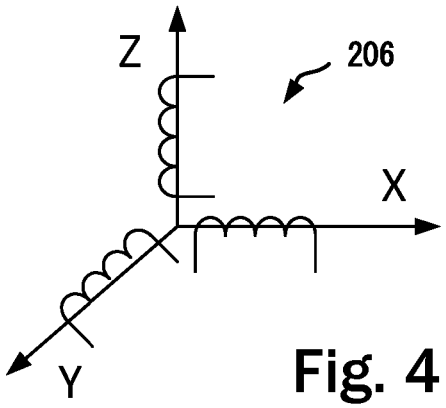

Fig. 4

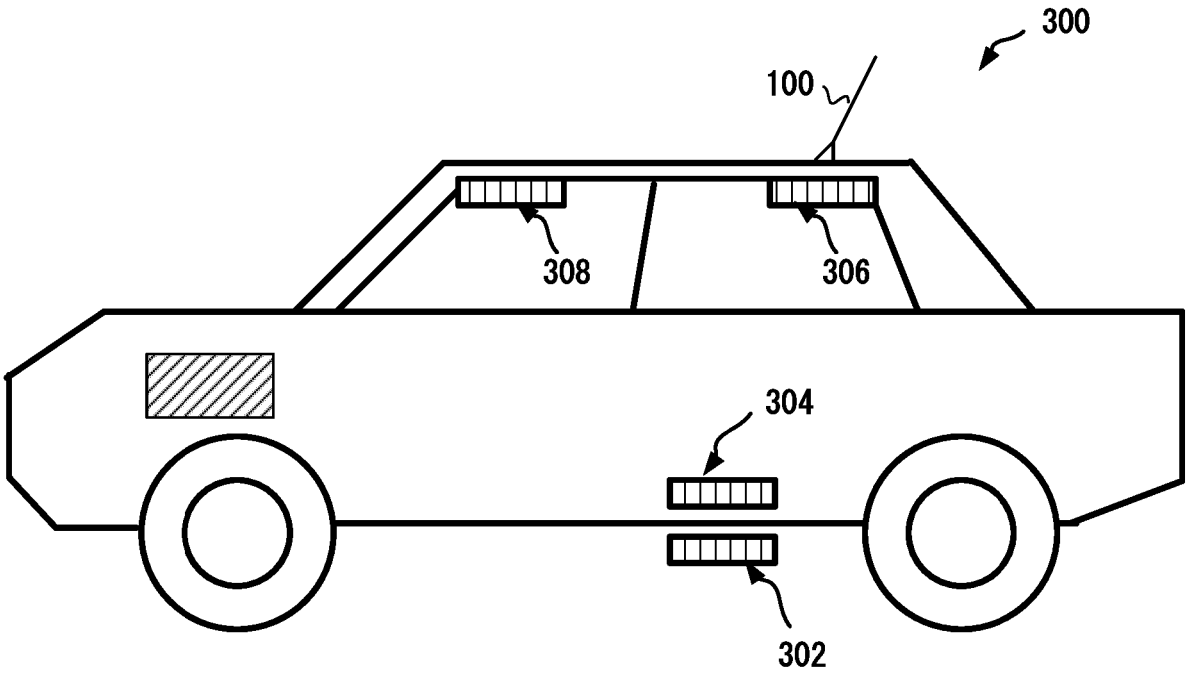

Fig. 5

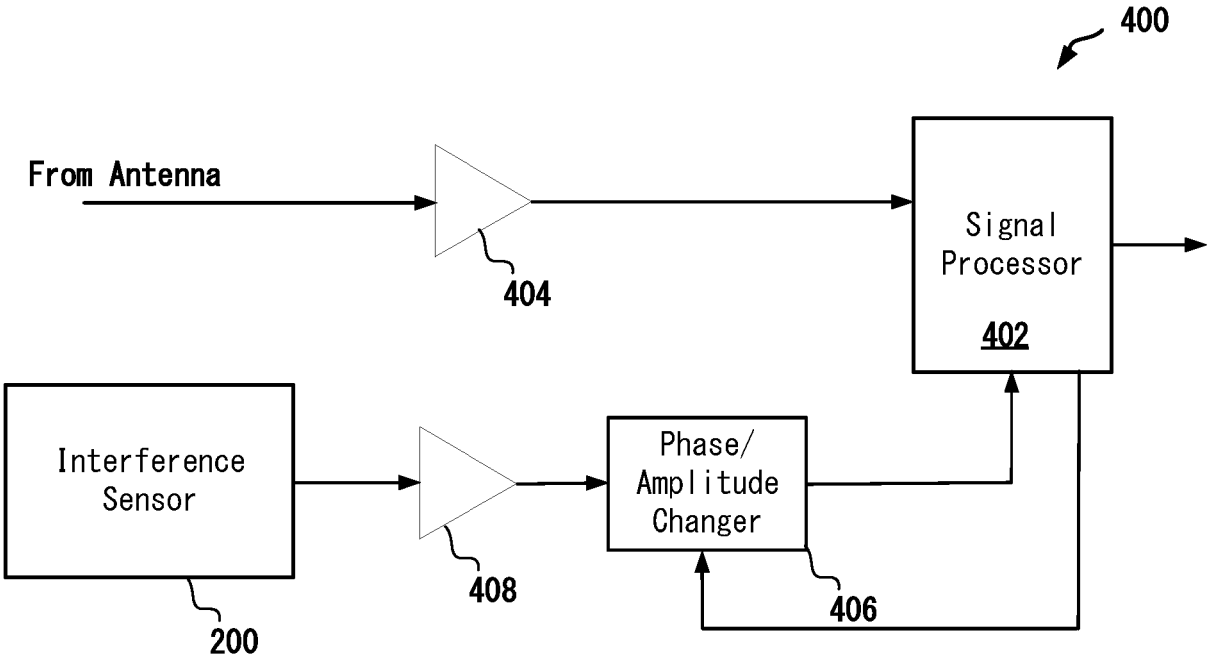
400
From Antenna
404
Signal Processor
402
Interference Sensor
200
408
Phase/ Amplitude Changer
406

Fig. 6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2011176659 A **[0002]**